TM 11-957

WAR DEPARTMENT TECHNICAL MANUAL

RECTIFIER RA-87

WAR DEPARTMENT • *JUNE 1943*

TECHNICAL MANUAL
No. 11-957

WAR DEPARTMENT
WASHINGTON, June 19, 1943

RECTIFIER RA-87

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*This manual supersedes TM 11-957, dated Jan. 14, 1943 and Mar. 10, 1943.

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DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander, or when you are in immediate danger of capture.

HOW — 1. Smash or cut—Use sledges, axes, hand-axes, pick-axes, hammers, crowbars, heavy tools, large rocks, or explosives such as TNT, grenades, firearms, etc.

2. Burn—Use gasoline, kerosene, oil flame-throwers, incendiary grenades, etc.

3. Disposal—Bury in slit trenches, fox-holes, other holes. Throw in streams. Scatter.

4. USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash—Rectifier stack, transformer, capacitors, all other parts, and chest.

2. Burn—Technical manuals and chest.

DESTROY EVERYTHING

SAFETY NOTICE

SEVERE SHOCK MAY RESULT FROM CONTACT WITH CURRENT-CARRYING PARTS OF THIS EQUIPMENT. ALWAYS BE SURE THAT THE SWITCH IS *OFF* BEFORE MAKING ADJUSTMENTS ON THE TAP-CHANGING PANEL.

THIS SUPPLEMENT WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL DEPARTMENT OF THE ARMY PUBLICATION.

SUPPLEMENT

9 APRIL 1951

SUPPLEMENT TO
TM 11-957
RECTIFIER RA-87

The following information, published on Order No. 6510-Phila-51, supplements TM 11-957, 19 June 1943, as changed by Changes No. 1, 4 November 1944. The serial numbers of the equipment covered in this supplement are:

Name	*Serial numbers*
Rectifier RA-87-A	327 to 808 incl.

Personnel using this equipment and having custody of this technical manual will enter suitable notations beside each affected paragraph and figure in the technical manual to indicate the presence of this supplementary information.

Note. Rectifier RA-87-A is essentially the same as Rectifier RA-87. The information in TM 11-957 which applies to Rectifier RA-87 applies equally to Rectifier RA-87-A, except where otherwise specified in this supplement.

Page 3. Par. 2. Add the following after the last sentence of subparagraph 20: *"Chest CH-158-(*)"* (fig. 2.1), supplied with Order No. 6510-Phila-51, provides a protective box for use in transporting the rectifier and technical manuals.

Page 3. Par. 2. Add the following after paragraph 2:

2.1. Differences between Models.

Rectifier RA-87 and Rectifier RA-87-A are essentially alike and may be used interchangeably. The chief differences between the two models are in the d-c fuse and fuse mounting. Rectifier RA-87 has a 5-ampere, cartridge fuse and a clip-type fuse mounting (6 and 5, fig. 3); Rectifier RA-87-A has a ½-ampere, time-delay fuse and a bayonet-extractor-type fuse mounting (5, fig. 3.1). Rectifier RA-87-A

is provided with an additional fuse holder which serves as a container for a spare fuse.

Page 3. Fig. 1. Insert figure 1.1 after figure 1.

Page 4. Fig. 2. Insert figure 2.1 after figure 2.

Page 6. Fig. 3. Insert figure 3.1 after figure 3.

Page 6. Par. 1. In subparagraph a, change the second sentence to read: Be sure that the cord supplying power to the **motor** of the teletypewriter is plugged into the 115V AC receptacle of the rectifier which is black, **not** the 115V **DC** receptacle which is brown.

Page 8. Par. 10. Change the first sentence to read: Figures 5 and 5.1 are the complete schematic diagrams for Rectifier RA-87 and Rectifier RA-87-A, respectively.

Page 8. Fig. 5. Insert figure 5.1 after figure 5.

Page 10. Par. 14. Change the sentence just before "CAUTION" to read: Figures 3, 3.1, 6, 6.2, and 7 show the location of parts.

Page 10. Fig. 6.1. Insert figure 6.2 after figure 6.1 (see C1).

Page 10. Fig. 7. Change caption to read: *Rectifiers RA-87 and RA-87-A, bottom view of chassis.*

Page 11. Par. 15. Make the following changes in subparagraph b:

At the end of the third sentence, change "(See fig. 3)" to read: (fig. 3) (RA-87) or fig. 3.1 (RA-87-A).

At the end of the fourth sentence, change "(see fig. 6)" to read: (fig. 7).

Page 11. Fig. 8. Insert figure 8.1 after figure 8.

Page 14. Par. 19. Insert the following "Note" after paragraph 19:

Note. When a new rectifier is being installed, tag the leads carefully as they are disconnected from the taps of the old rectifier and be careful to connect them to the new rectifier so that the polarity is correct.

Page 16. Par. 20. Add the following after paragraph 20:

20.1 Identification Table of Parts for Rectifier RA-87-A

Note. The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as T/O&E, T/A, T/BA, SIG 7&8, SIG 7-8-10, SIG 10, list of allowances of expendable material, or another authorized supply basis. The Department of the Army Supply Catalog applicable to the equipment covered in this manual is SIG 7&8-RA-87. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1, Introduction and Index.

20.1. Identification Table of Parts for Rectifier RA-87-A (contd)

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	RECTIFIER RA-87-A: selenium disk type; input, 95- to 125-v or 190- to 250-v, 50 to 60 cyc AC, 600 v; output 115-v DC at 400 ma and 115-v AC, 500 W at 50/60 cyc.	Provides power for teletypewriter line circuits and for the operation of teletypewriter motors.	3H699-87
	BOARD, terminal: tap and fuse panel assembly; 12 brass screw terminals; 2 fuseholders.	Mounts the transformer and rectifier voltage-changing taps and the ½-ampere fuses.	3H409-1
	BOARD, terminal: 2 brass, tin plated terminals.	Provides a mounting for the power input connections.	3Z770-2.52
8	CABLE, power: 2 #18 AWG stranded conductors; rubber sheath; approx 7 ft lg.	Conducts current from the power source to the rectifier.	1B818.14
4-1, 4-2	CAPACITOR, fixed: electrolytic; 500 uf ±20%; 200 vdcw.	Serves as filter capacitor to smooth pulsating dc.	3DB500-5
	CLAMP: cable; accommodates ¼" cables.	Secures cable.	2Z2636-6
16	CLIP: fuse; uninsulated; 9/16" max jaw opening.	Secures 15-ampere cartridge fuse.	3Z1029-1
	CONNECTOR, plug: 2 flat, parallel, blade contacts; straight.	Provides contact between power source and power cable conductors.	6Z1727-2
12-1, 12-2	CONNECTOR, receptacle: 2 curved, twist-lock, female contacts; straight.	Provides means of connecting equipment to d-c output of rectifier.	6Z7815

20.1. Identification Table of Parts for Rectifier RA-87-A (contd)

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
11-1, 11-2, 11-3	CONNECTOR, receptacle: 2 T-shaped, female contacts; straight.	Provides means of connecting equipment to a-c output.	6Z7811
6	FUSE, cartridge: ½ amp, 250 v, time-delay.	Protects d-c circuit.	3Z2595.7
17	FUSE, cartridge: 15 amp, 250 v, ferrule contact.	Protects d-c circuit.	3Z1903-15
5	FUSEHOLDER: bayonet-extractor type; for single 3AG cartridge fuse.	Secures ½-ampere fuse.	3Z1939
	LABEL: circuit; 13⅞" lg x 7½" wd.	Wiring diagram; used to trace circuits and find connections.	6D16824
	LABEL: warning; printed "warning, use ½ amp time-delay fuse only."	Warns against using incorrect fuse in d-c circuit.	6D16980-1
	PANEL BOARD, fuse: marked "Spare and 15A" in white.	Provides mounting for and shows location of 15-ampere fuse and spare.	3H4109.1-11
	PANEL BOARD, fuse: marked "Spare, ½ amp time-delay, rect tape" in white.	Provides mounting for and shows locations of taps and ½-ampere fuse and spare.	3H4109.1-12
2	REACTOR: swinging choke; .8 henry at no load to .23 henry at 400 ma; 3-ohm d-c resistance, hermetically sealed.	Filters d-c output of rectifier.	3C347
3	RECTIFIER, metallic: full wave, selenium-disk type; input 180-v, 60 cyc, single-phase AC; output 120-v DC, .4 amp.	Converts a-c input to d-c output.	3H4860-23

18	RESISTOR, fixed: WW; 2000 ohms ±5%; 12 W; JAN type RW32D202.	Bleeder resistor.	3RN26125
7	SWITCH, toggle: DPST; JAN No. ST52K.	ON-OFF switch to start and stop rectifier.	3Z9863-52K
	TERMINAL, lug: ring type; for #18 AWG wire, with #10 stud hole.	Provides means of connecting lead to stud.	3Z12046-1
	TERMINAL, lug: ring type; for #18 AWG wire, with #8 stud hole.	Provides means of connecting lead to stud.	3Z12046-2
	TERMINAL, lug: ring type; for #18 AWG wire, with ¼″ stud hole.	Provides means of connecting lead to stud.	3Z12505-5.12
	TERMINAL, lug: spade type; for #18 AWG wire.	Provides means of connecting leads to transformer and rectifier taps.	3Z12050-5.6
	TERMINAL, stud: with #8-32 x 5/16 in brass screw, nickel plated.	Provides means of connecting transformer and rectifier taps to leads.	3Z12073
1	TRANSFORMER, power: plate type; input 95- to 125-v or 190- to 250-v, 50 to 60 cyc, single-phase ac; secondary output 400 ma at 115v; 4 voltage-adjustment taps; hermetically sealed.	Converts various input voltages to correct voltage to supply rectifier and to provide 115-v a-c output.	2Z9605.3

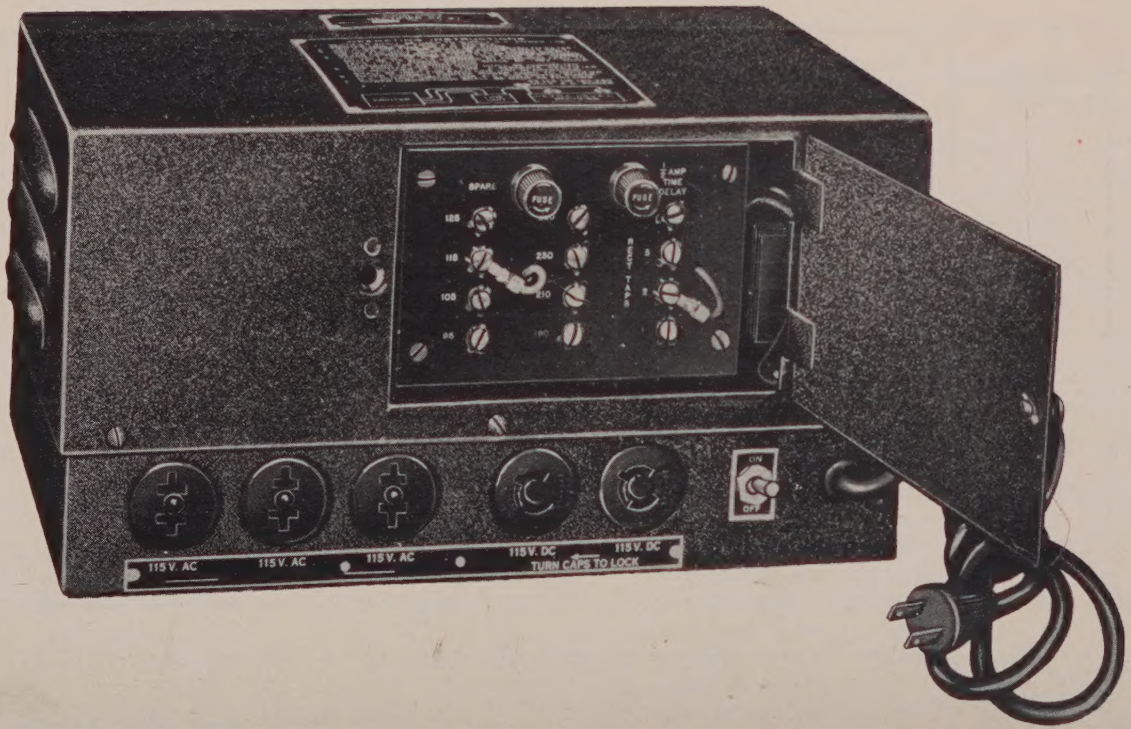

Figure 1.1. Rectifier RA-87-A, front view with door open showing tap-changing panel.

Figure 2.1. Chest CH-158.

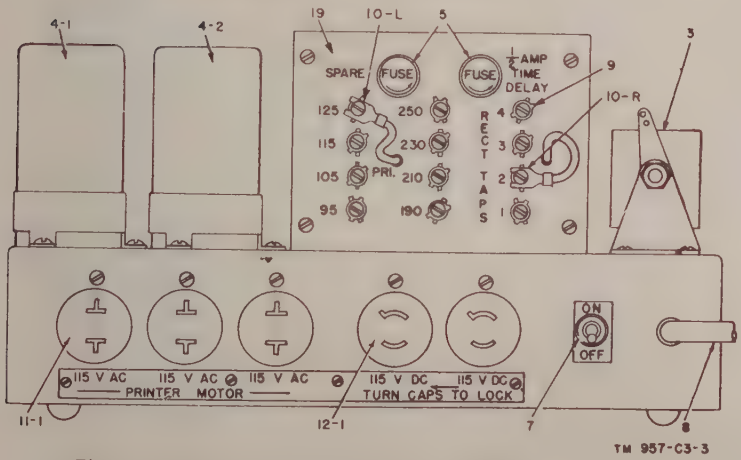

Figure 3.1. Rectifier RA-87-A, front view with cover removed.

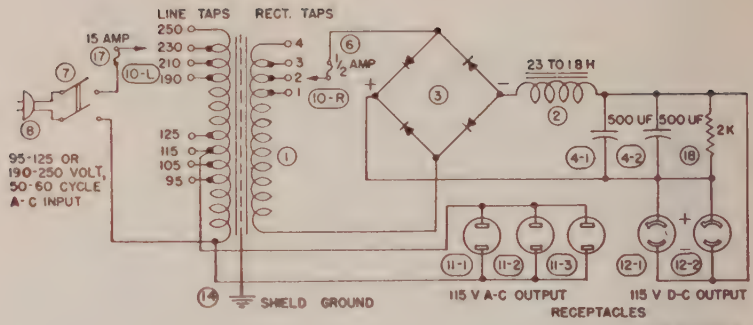

Figure 5.1. Rectifier RA-87-A, schematic diagram.

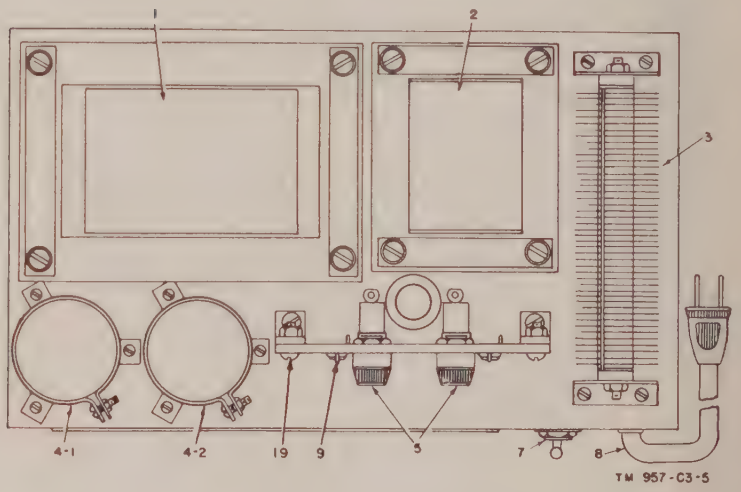

Figure 6.2. Rectifier RA-87-A, top view of chassis.

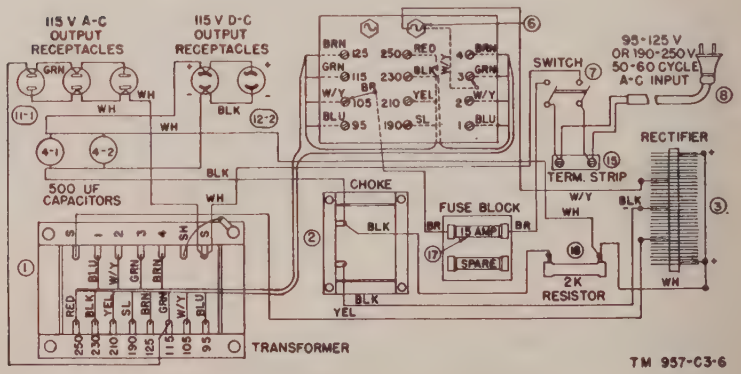

Figure 8.1. Rectifier RA-87-A, wiring diagram.

TECHNICAL MANUAL

RECTIFIER RA-87

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 4 November 1944.

TM 11-957, 19 June 1943, is changed as follows:

SECTION IV

MAINTENANCE

Note.—Failure or unsatisfactory performance of this equipment will be reported immediately on WD AGO Form 468. If this form is not available, see TM 38-250.

* * * * * * *

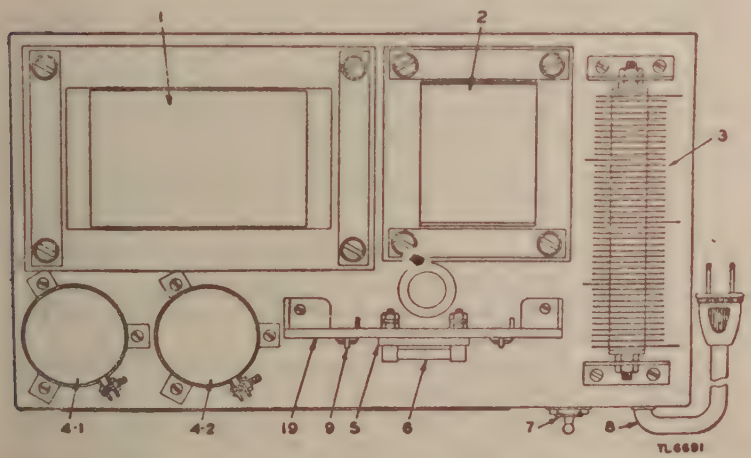

FIGURE 6.1.—Rectifier RA-87, top of chassis on models with one-piece, plastic, tap-changing panel.

Note.—The one-piece, molded, plastic, tap-changing panel ((19), fig. 6.1) is used on all Rectifiers RA-87 made by the Horni Signal Mfg. Co., instead of the bakelite panel used on other models of Rectifier RA-87.

* * * * * * *

18. Circuit resistances.—All measurements are made with the parts under test disconnected from other circuits.

AGO 90C 610403°—44

RECTIFIER RA-87

a. Transformer (ref. No. 1).

Primary		Secondary	
Terminals	Resistance	Terminals	Resistance
S to 95	1.00 ohms	S to #1	2.15 ohms
S to 105	1.02 ohms	* * *	*
* * *	*	S to #4	2.36 ohms
S to 230	2.10 ohms		
S to 250	2.26 ohms		

The following table of transformer resistances applies to all Rectifiers RA-87 manufactured by the Horni Signal Mfg. Co.

Primary		Secondary	
Terminals	Resistance	Terminals	Resistance
S to 95	0.689 ohms	S to #1	3.47 ohms
S to 105	0.723 ohms	S to #2	3.57 ohms
S to 115	0.758 ohms	S to #3	3.68 ohms
S to 125	0.794 ohms	S to #4	3.91 ohms
S to 190	1.270 ohms		
S to 210	1.438 ohms		
S to 230	1.582 ohms		
S to 250	1.761 ohms		

* * * * * * *

19.1. Moistureproofing and fungiproofing (Added).—*a. General.*—Communication failures commonly occur when Signal Corps equipment is operated in tropical areas where temperature and relative humidity are extremely high. The following problems are typical:

(1) Resistors, capacitors, coils, chokes, transformer windings, etc., fail.

(2) Electrolytic action takes place in resistors, coils, chokes, transformer windings, etc., causing eventual break-down.

(3) Hook-up wire and cable insulations break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs.

b. Treatment.—A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing.

c. Step-by-step instructions for treating Rectifier RA-87.—(1) *Preparation.*—Make all repairs and adjustments necessary for the proper operation of the equipment.

(2) *Disassembly.*—(*a*) With the rectifier in an upright position, remove the screws securing the top cover to the chassis, and lift off the cover.

(*b*) With the rectifier resting on the rear surface of the chassis, remove the screws holding the bottom plate of the chassis, and lift off the bottom plate.

(*c*) Remove the two 15-ampere cartridge fuses from the mounting block.

(*d*) Remove the two nuts securing the fuse mounting block to the chassis, and lift off the block to expose the wiring at the rear.

(*e*) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

(3) *Masking.*—(*a*) Completely mask or cover the selenium rectifying unit to prevent varnish from contacting it. To do so, mold paper around the stacks, securing it in place with masking tape.

(*b*) Mask or cover the fuse clips and fuse block engraving to prevent varnish from contacting them.

(4) *Drying.*—Place Rectifier RA-87 in an oven or under a heat lamp, and dry it for 2 to 3 hours at 160° F.

(5) *Varnishing.*—(*a*) Apply three coats of Lacquer, Fungus-resistant, Spec. No. 71-2202 (Stock No. 6G1005.3), or equal, with a spray gun to the edges of the bakelite fuse block and to all wiring and soldered connections inside the chassis.

(*b*) With the rectifier resting upright, apply varnish with a brush to the edge of the bakelite connection panel and to all wiring and soldered connections on top of the chassis.

Caution.—THE LACQUER AVAILABLE FOR THIS TREATMENT CONTAINS PHENOL MERCURIAL WHICH WILL DAMAGE SELENIUM RECTIFIER STACKS. ALWAYS MASK THE STACKS COMPLETELY BEFORE SPRAYING THE UNIT. DO NOT SPRAY CLOSER THAN 1 INCH FROM THE ENDS OF THE STACKS. VARNISH SPRAY MAY HAVE A TOXIC EFFECT. USE RESPIRATOR IF AVAILABLE; OR TIE CHEESECLOTH OVER NOSE AND MOUTH.

(6) *Reassembly.*—(*a*) Remove all masking tape and all protective paper coverings.

(*b*) Clean all contacts with varnish remover, and burnish the contacts.

(*c*) Reassemble the rectifier, and test its operation.

(7) *Marking.*—Mark the equipment MFT and the date of treatment. *Example:* MFP 5 June 1944.

20. (Superseded.) MAINTENANCE PARTS LIST FOR RECTIFIER RA-87.

Reference symbol	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Orgn stock	3d echn	4th echn	5th echn	Depot stock	† Station stock	† Region stock
1	2Z-9605.3	TRANSFORMER: primary, 95- to 250-v; secondary, tapped for correct voltage.	1	------	------	------	------	------	------	------	(*)
2	3C347	CHOKE: 0.23 to 1.8-h	1	------	------	------	------	------	------	------	(*)
3	3H4860	RECTIFIER STACK: selenium; dry disk; GE Co. No. 6RS41GE1; or Horni No. B4D9U1 with mounting brackets; (rectifies a-c input); Benwood Linze 1D089FFIC.	1	------	------	------	(*)	(*)	(*)	------	(*)
C1, 4-2	3DB500-5	CAPACITOR: fixed; electrolytic; 500-mf, 200 v d-c (working) plus 20 percent, minus 10 percent; Aerovox 2E; Industrial Corp 20B70; (filters d-c output).	2	------	------	(*)	(*)	(*)	(*)	(*)	(*)
18	3Z6200-43	RESISTOR: 2,000-ohm; 20-w; Utah Radio Co. X-1103; (bleeder resistor for d-c circuit).	1	------	------	(*)	(*)	(*)	(*)	------	(*)
6	3Z2605.2	FUSE: 5 amp, 250-v; Littlefuse 3AG, 1358 or Bussman MTH; (fuses d-c circuit).	1	5	------	(*)	(*)	(*)	(*)	(*)	(*)
17	3Z1903-15	FUSE: 15 amp, 250-v; Federal Spec. W-F-791; (fuses a-c circuit).	1	5	------	(*)	(*)	(*)	(*)	(*)	(*)
5	3Z3256	FUSE MOUNTING: Littlefuse No. 1056; (for 5-amp d-c fuse).	1	------	------	(*)	(*)	(*)	(*)	------	------
16	3Z1029-1	CLIP: fuse; Square "D" Co. SK2371, 30-amp, 250-v; SC-D-9543-21; (for fuse in a-c circuit).	4	------	------	(*)	(*)	(*)	(*)	------	------
7	3Z9849.18	SWITCH: toggle; DPST; Cutler-Hammer No. 7320; (power switch).	1	------	------	(*)	(*)	(*)	(*)	------	(*)
8	3E4060	CORD ASSEMBLY: 7-ft; 2-conductor; No. 18AWG, black rubber sheath; (power supply cord).	1	------	------	(*)	(*)	(*)	(*)	------	(*)

RECTIFIER RA-87

11	6Z7789	RECEPTACLE: bakelite; screw hole 1¾" on centers tapped for 2-32 screws; 1⅛" diam; 10-amp. 250-v; 15-amp. 125-v (a-c output).	3	------	(*)	(*)	(*)	----	(*)
12	6Z7815	RECEPTACLE: twist-tite; (d-c output).	2	------	(*)	(*)	(*)	----	(*)
15	3U4699-87/P1	TERMINAL PANEL: bakelite	1	------	------	------	------	----	(*)
13, 14	3Z12046-1	TERMINAL: copper; Patton MacGuyer No. 2063 (connects transformer shield lead to chassis, also connects leads to power switch and to 5 and 15 amp fuse clips).	9	------	(*)	(*)	(*)	----	----
10	3Z12046-2	TERMINAL: copper; Patton MacGuyer No. X 991 (connects leads to tap terminals and a-c receptacles).	12	------	(*)	(*)	(*)	----	----
	3Z12050 5.3	TERMINAL: lug, ring type; brass, bottoned; Patton MacGuyer No. 2052; double ears without bridge; approx ⅞" long x ⅜" wide; ¼" diam stud hole; (connects lead to capacitor terminals).	4	------	(*)	(*)	(*)	----	----
9	3Z12073	TERMINAL: screw, brass, tin-plated; with 8-32 x ⅜" brass screw, nickel-plated; H. B. Jones No. 50-TAS; (top panel terminals).	12	------	(*)	(*)	(*)	----	----
	61.6832 1	SCREW: machine; No. 8-32 x ¼"; flat-head; brass; receptacle mounting.	10	------	(*)	(*)	(*)	----	----
	61.6632 40.87	SCREW: machine, No. 6-32 x 2¼", roundhead; iron; (resistor mounting SC-D-9543-35).	1	------	(*)	(*)	(*)	----	----
	6D1682 1	LABEL: circuit, 80# coated white book paper; approx. 7⅛" x 13⅛"; SC-D-9542; coated both sides with silver spraying lacquer.	1	------	(*)	(*)	(*)	----	----

† Parts not stocked in station or region stock are carried in depot stock.
* Indicates stock available.

21. List of manufacturers. Rescinded.

[AG 300.7 (4 Sep 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

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IBn 1: T/O 1-277S; 1-317; 1-392S; 1-637S; 1-759; 1-768.

IC 11: T/O 11-107; 11-127; 11-237; 11-287; 11-478S; 11-587; 11-597.

For explanation of symbols, see FM 21-6.

AGO 900

U. S. GOVERNMENT PRINTING OFFICE: 1944

SECTION I
DESCRIPTION

Paragraph
General 1
Description 2
Power 3
Weights and dimensions 4

1. **General.**—*Rectifier RA-87* converts 95- to 125-volt, or 190- to 250-volt, 50- to 60-cycle, a-c power to 115-volt, d-c power for the operation of teletypewriter line circuits. In addition, it provides 115-volt, a-c power for the operation of teletypewriter motors.

2. **Description.**—The rectifier base or chassis, which mounts all parts and connections, is enclosed at top and bottom with sheet steel covers. The top cover has a small door to give access to the voltage tap-changing panel, as shown in figure 1. Two twist-type receptacles for d-c loads, three receptacles for a-c loads, an OFF-ON switch, and the input power cord are located on the front of the chassis. Condensed operating instructions are given on the top cover, and schematic and wiring diagrams are fastened to the inside of the top cover. *Chest CH-158*, shown in figure 2, provides a protective box for use in transporting the rectifier and technical manuals.

FIGURE 1.—Rectifier RA-87, front view with door opening showing tap-changing panel.

3. Power.—*a. Input.*—The maximum input power is approximately 600 watts with full load on both the a-c and the d-c output circuits. The input circuit of the rectifier can be arranged on the tap-changing panel for approximate power source voltages of 95, 105, 115, 125, 190, 210, 230, and 250 volts at 50 to 60 cycles.

b. Output.- The following output powers are available, either at the same time or separately.

(1) *Direct current.* Up to 46 watts, 400 milliamperes at 115 volts.

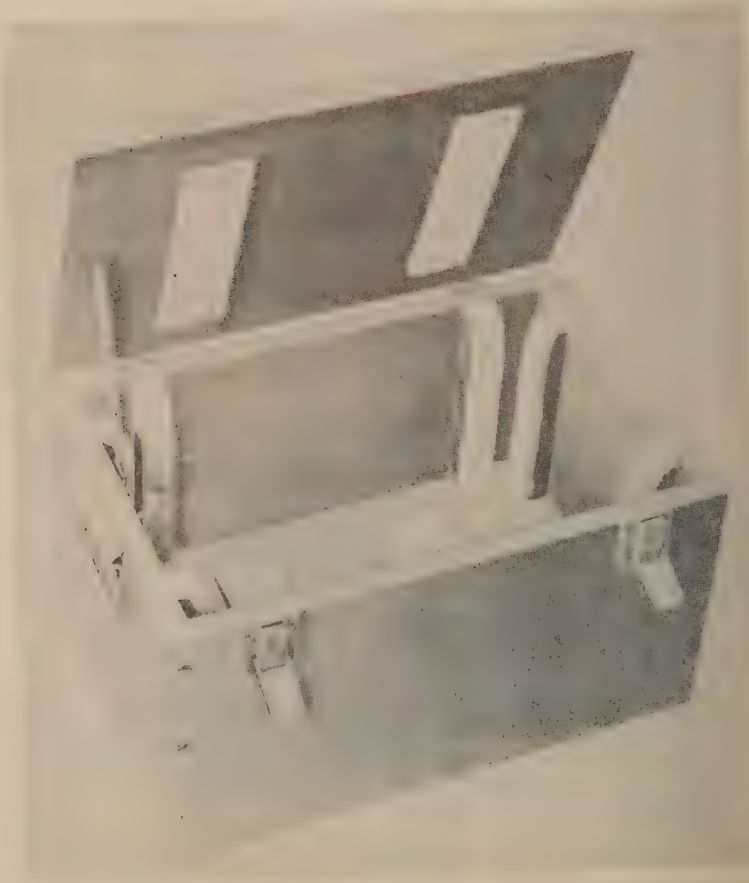

FIGURE 2.—Chest CH-158.

(2) *Alternating current.* — Up to 500 watts, 4.35 amperes at 115 volts.

4. Weights and dimensions.—The weights and dimensions of the rectifier and its packing chest are:

Rectifier RA-87—40 lb., $8\frac{3}{8}$" x $14\frac{9}{16}$" x $7\frac{1}{2}$" high.
Chest CH-158 —18.5 lb., $12\frac{5}{8}$" x $18\frac{1}{2}$" x $10\frac{3}{4}$" high.

Two copies of this manual (TM 11-957) are to be packed with the rectifier at all times. Chest CH-158 is not a component of the rectifier but is generally used with it.

SECTION II
INSTALLATION AND OPERATION

	Paragraph
Installation	5
Voltage adjustment	6
Connections	7
Operation	8
Packing for transportation	9

5. Installation. — *a.* Release the two cover latches of Chest CH-158 and raise the cover until it rests against its support chain. Remove the input power cord first so that it will not wedge between the rectifier and the side of the chest. Remove the rectifier from the chest, using the louvers at each end as lifting handles. If the rectifier sticks hold the chest with your feet or knees.

b. Put the rectifier in a cool, dry, well-ventilated place near the teletypewriter equipment which it is to supply. Avoid a position subject to direct sunlight. Use of the chest as a table or support for the rectifier will facilitate setting the voltage taps and will keep the rectifier off damp ground or dirty floors.

c. Check the rectifier for loose or broken parts. Shake it to see if any loose parts can be detected. Repair any defects which are found.

6. Voltage adjustment. — *a. Power source.* — Check the power source to be sure that it is 95- to 125-, or 190- to 250-volt, 50- to 60-cycle alternating current. *Never connect the input power cord to a d-c source.* Voltage and frequency are shown on the nameplates of gas engine power units; this information can be obtained from the agency furnishing the power, or from nameplate data on equipment connected to the power source. If in doubt as to whether the power source is alternating or direct current, check it with a d-c voltmeter such as the one in Line Unit BE-77-A. Alternating volt-

ages will give a very small vibrating or jiggling indication on the meter.

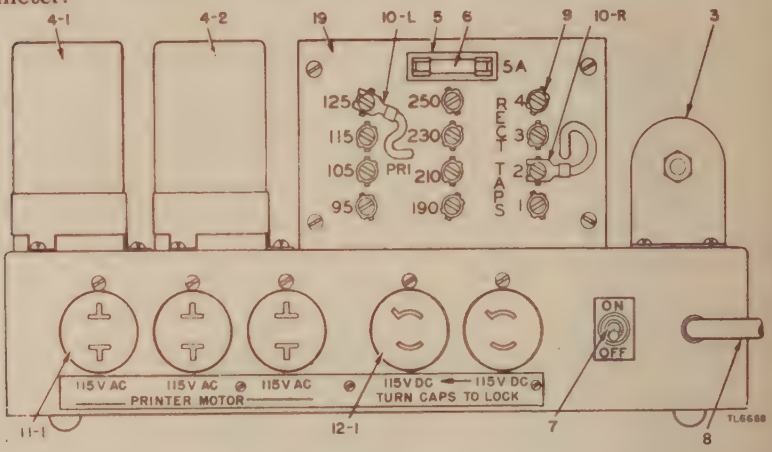

FIGURE 3.—Rectifier RA-87, front with cover off—parts location diagram.

b. Tap setting (see fig. 3).—Before connecting the rectifier, set the left-hand movable PRI lead on the tap-changing panel to the terminal most nearly corresponding to the voltage of the power source. If in doubt as to the voltage of the a-c power source, set this lead on the 250-volt tap. Plug the input power cord into the power source, flip the rectifier ON-OFF switch to ON, and check the voltage at the d-c output receptacles to see that it is between 115 and 120 volts. If this voltage is more than 120, or less than 110 volts, throw the ON-OFF switch to OFF and readjust the taps on the tap-changing panel. Throw the switch to ON and check the voltage. Continue to readjust the taps until the proper voltage is obtained. The right-hand lead (RECT TAPS) will provide adjustment of the output voltage in steps of 3 to 4 volts each with the voltage increasing as the tap is moved toward number 4.

7. Connections.—*a.* The rectifier ordinarily will be connected to one teletypewriter or similar equipment as shown in figure 4 and on the instruction plate. Be sure that the cord supplying power to the *motor* of the teletypewriter is plugged into the 115V *AC* receptacle of the rectifier, *not* the 115V *DC* receptacle. The d-c plug should be locked tightly in place by turning it in a clockwise direction.

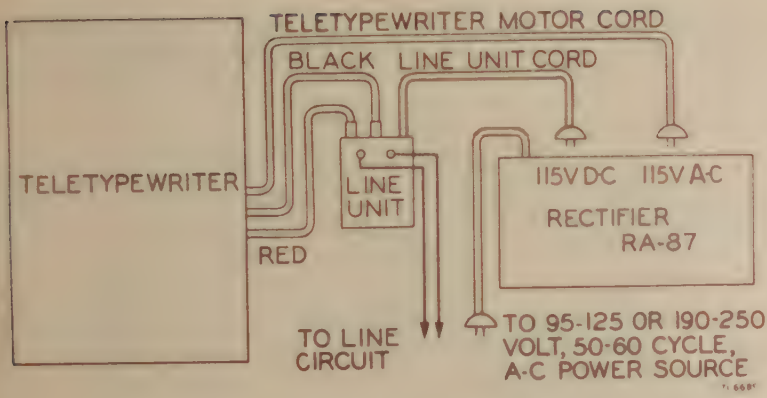

FIGURE 4.—Rectifier RA-87, usual cording diagram

b. While it is preferable to supply current for only one teletypewriter set or similar equipment from the rectifier and while a separate rectifier is ordinarily used with each such equipment, there may be times when enough rectifiers are not available for the teletypewriter sets or similar equipment to be operated. In such cases, several sets can be supplied from one rectifier, if care is exercised to make the different d-c connections so as not to short-circuit the rectifier output and if the power output ratings indicated in paragraph 3*b* are not exceeded. A low resistance ground or common return circuit must be used if more than one line current is supplied. When supplying both line and local current to a teletypewriter set, there will be a load of about 140 milliamperes. If only local current is supplied, the load will be about 80 milliamperes. The average teletypewriter motor has a maximum running current of about 1.4 amperes. In some cases, d-c loads of over 250 or 300 milliamperes may cause interference between the operation of the different equipments.

8. Operation.—When installed and connected as indicated in the previous paragraphs, the rectifier can be stopped and started by means of the OFF-ON switch. The only observable indications of its operation are a faint audible hum in the power transformer and a gradual rise in the temperature of the case. At full load the maximum temperature is reached after 4 to 5 hours of operation.

9. Packing for transportation.—Disconnect all connections to the rectifier receptacles. Remove the power cord from the power source. Place the rectifier right side up in Chest CH-158 with its front toward the front of the chest. Place the cord in the space between the front

of the rectifier and the front side of the chest. Place the technical manuals behind the rectifier; close and secure the chest lid.

SECTION III
FUNCTIONING OF PARTS

Paragraph
Circuit 10
Transformer (ref. no. 1) 11
Rectifier (ref. no. 3) 12
Filter 13

10. Circuit.—Figure 5 is the complete schematic diagram of Rectifier RA-87. The functions of the different parts are discussed in the following paragraphs.

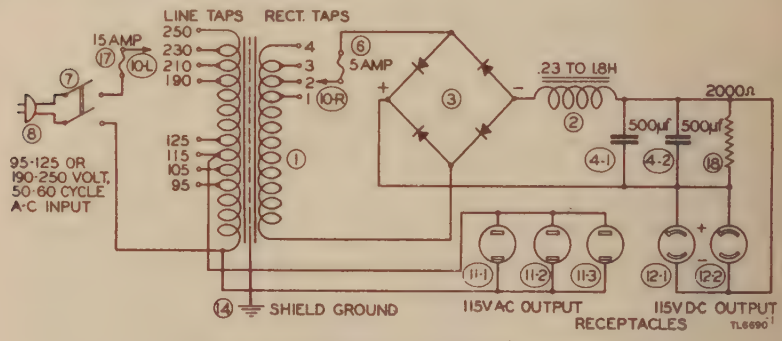

FIGURE 5.—Rectifier RA-87, schematic diagram.

11. Transformer (ref. no. 1).—The primary winding of the transformer is connected through 15-ampere line fuse 17, ON-OFF switch 7, and cord and plug assembly 8 to the a-c source of power. Taps on the primary winding suitable for the different input voltages are connected to the line by means of tap lead 10-L. In addition to its function as the transformer primary winding, this winding also functions as an auto-transformer for supplying 115 volt a-c power from the different input voltages. Depending upon the RECT TAP used, the secondary winding furnishes a-c power at 140, 145, 150, or 155 volts to the rectifier disks. Thus the RECT TAP adjustment provides for setting the d-c *output voltage* in three 3.5-volt steps regardless of the alternating voltage applied to the input plug or obtained from the a-c output receptacles.

12. Rectifier (ref. no. 3).—The rectifier consists of a stack of rectifying selenium disks. The stack is divided into four sections by terminals at the ends, quarter-points, and center. The terminals

are connected to form a full-wave, bridge rectifier circuit; the disks are so arranged that they will conduct current only from the end or quarter-point terminals towards the center terminal. With alternating current from the transformer secondary winding connected to the two quarter-point terminals, the center terminal becomes the positive d-c terminal and the end terminals, which are connected together, become the negative d-c terminal. Current is carried by the first and third sections of the rectifier stack during one half-cycle of each full cycle of alternating current and by the second and fourth sections during the other half-cycle. A pulsating d-c output is obtained from the rectifier stack.

13. Filter.—*a.* The filter consists of *choke 2* and *capacitors 4-1 and 4-2*. The filter changes the pulsating d-c output of the rectifier into almost pure direct current for the d-c output receptacles. The actual variation of the voltage at the receptacles is less than 0.5 volt with any fixed resistance load. *Bleeder resistor 18* provides a constant load for the rectifier and thus prevents the output voltage from rising too much when small d-c outputs are used.

b. Choke 2 is a swinging type choke. Its inductance changes from 1.8 henries at no load to 0.23 henries at full load current. This type of choke maintains a more constant output voltage with variation of the load than a smoothing type choke. The choke acts as a high impedance to the flow of pulsating current and as a low resistance to the flow of direct current.

c. Capacitors 4-1 and 4-2 provide a low impedance path across the output for any pulsating current which is passed by the choke. Thus, they keep the current supplied to any fixed load at a nearly constant value.

SECTION IV

MAINTENANCE

	Paragraph
Inspections	14
Procedure in case of failure	15
Locating trouble	16
Normal voltage and current readings	17
Circuit resistances	18
Replacing parts	19

14. Inspections.—When installed and checked as directed in paragraph 5, the rectifier requires little attention as long as it operates properly. Remove accumulated dust and dirt about once a month using compressed air, a bellows, or a soft long bristled brush. Be sure to remove all dust and dirt between the radiating disks of the rectifier stack (ref. no. 3). There are no moving parts requiring

lubrication. Look for signs of moisture and remove the cause. Figures 3, 6, and 7 show the location of parts.

CAUTION. DO NOT ATTEMPT TO DRY EQUIPMENT WITH VERY HOT AIR BECAUSE THE CAPACITORS AND RECTIFIER DISKS MAY BE INJURED. A FREE FLOW OF MODERATELY WARM AIR THROUGH A CHASSIS WILL DO THE NECESSARY DRYING MORE QUICKLY THAN VERY WARM AIR NOT IN MOTION.

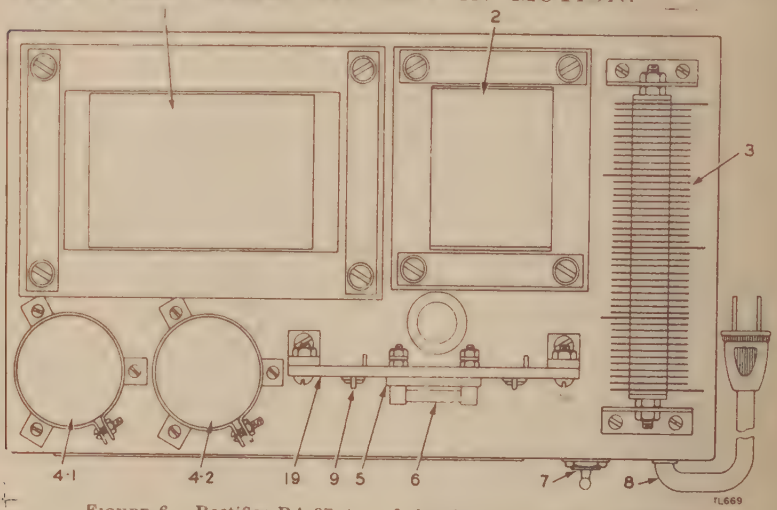

FIGURE 6.—Rectifier RA-87, top of chassis—parts location diagram.

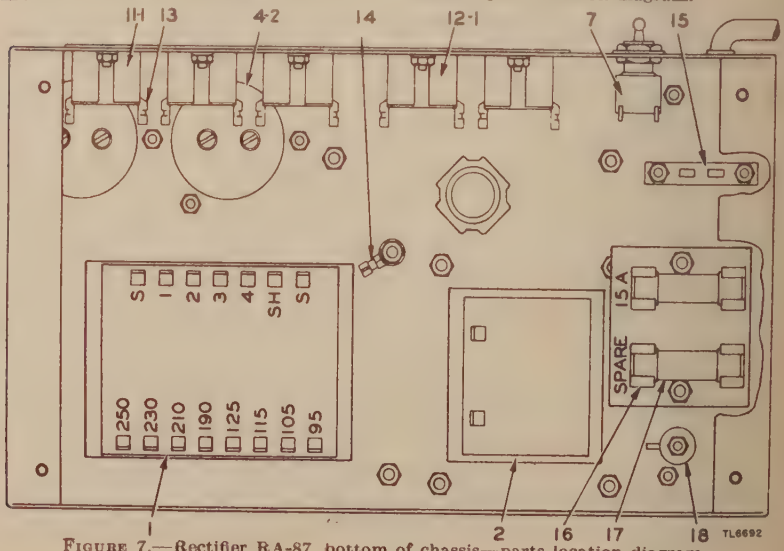

FIGURE 7.—Rectifier RA-87, bottom of chassis—parts location diagram.

15. Procedure in case of failure. *a. General.* The following general checks will remedy most causes of failure or apparent failure of the rectifier. Check to see that the power cord plug makes good contact, that the power source is operating, that the switch is turned to the ON position, and that the plugs in the output receptacles make good connections. Check connecting cords for worn or broken places and check fuses (see following subparagraph *b*). If the trouble still seems to be in the rectifier, proceed as indicated in paragraph 16.

b. Fuses.—Check both a-c and d-c fuses. Turn ON-OFF switch to OFF before removing fuses. The d-c fuse (ref. no. 6) is located on the tap-changing panel (see fig. 3). The a-c fuse (ref. no. 17) is located underneath the chassis behind the ON-OFF switch (see fig. 6). A blown fuse generally indicates trouble in the equipment connected to the output receptacles. Be sure to check or disconnect this equipment before replacing a blown fuse.

16. Locating trouble. *a. Procedure.* Make a voltage check of the various circuits starting at the a-c input and working toward the output. Normal voltages at different load currents are given in paragraph 17. If voltage checks are not possible or if any doubt exists as to the part causing trouble, check resistances for values indicated in paragraph 18. See following subparagraph *b* for possible causes of trouble. When the defective part has been determined, replace it as indicated in paragraph 19. The wiring diagram, figure 8, will be found helpful in tracing circuits and finding connections.

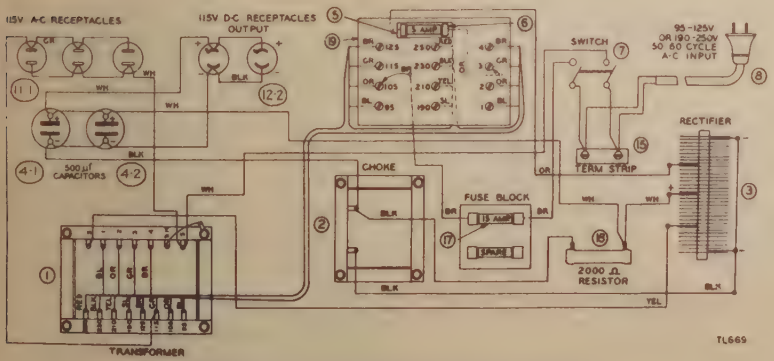

FIGURE 8.—Rectifier RA-87, wiring diagram.

b. Trouble chart.—Causes and symptoms of trouble are shown in the following chart.

Symptom	Cause
(1) No a-c output voltage	Open power cord. Short-circuited power cord. Poor plug contact. Burned out a-c fuse (ref. no. 17). Fuse loose in clip. Loose connection lug (ref. no. 10) to line tap terminal. Loose terminal (ref. no. 13) to receptacle. Burned out transformer (ref. no. 1). Defective switch (ref. no. 7).
(2) No d-c output voltage.	Burned out d-c fuse (ref. no. 6). Transformer secondary winding open. Fuse loose in clip. Loose connection lug (ref. no. 10) to rectifier tap terminal. Loose terminal (ref. no. 13) to receptacle. Defective choke coil (ref. no. 2). Defective rectifier (ref. no. 3). Defective capacitor (ref. no. 4-1 or 4-2). Poor plug contact.
(3) Improper a-c and d-c output voltages.	Wrong tap setting. Line voltage changed.
(4) Improper d-c output voltage but proper a-c output voltage	Rectifier tap improperly set.
(5) Excessively high d-c voltage.	Shorted choke coil (ref. no. 2). Open resistor (ref. no. 18).
(6) An a-c ripple in d-c output.	Defective choke coil. Defective capacitor. Defective rectifier.

17. Normal voltage and current readings.—The following data will be found useful in checking the functioning of the rectifier circuits:

CONDITIONS		POINT OF MEASUREMENT				
		Alternating current			Direct current	
		Line or transformer input	A-C receptacle output	Transformer secondary output[1]	Rectifier output	D-C receptacle output[2]
No-load, 115-v line and tap	Volts	115	115	147	120	120
	Amperes	0.34	0	0.070	0.060	0
No a-c load, full d-c load, 115-v line and tap	Volts	115	115	145	112	111
	Amperes	0.84	0	0.490	0.457	0.40
Full a-c and d-c loads, 115-v line and tap	Volts	115	115	145	112	111
	Amperes	5.00	4.35	0.490	0.457	0.40
Full a-c and d-c loads, 110-v line on 115-v tap[1]	Volts	110	107	137	106	105
	Amperes	4.80	4.15	0.490	0.455	0.40
No a-c load, full d-c load, 95-v line and tap	Volts	95	115	145	112	111
	Amperes	1.10	0	0.490	0.457	0.40
Full a-c and d-c loads, 95-v line and tap	Volts	95	112	142	109	108
	Amperes	5.80	4.25	0.490	0.457	0.40
Full a-c and d-c loads, 230-v line and tap	Volts	230	112	145	112	111
	Amperes	2.50	4.25	0.490	0.457	0.40

NOTES: [1]RECT TAP set on tap number 1 in all cases. A change of one tap position corresponds to a change of about 5 volts at this point and a change of about 3 5 volts in the voltage at the d-c output receptacles.

[2]The d-c output voltage at the receptacles may be raised to about 115 volts by changing the RECT TAP from number 1 to number 4. This has no effect on the a-c output voltage at the receptacles.

18. Circuit resistances.—All measurements are made with the parts under test disconnected from other circuits.

a. Transformer (ref. no. 1).

Primary		Secondary	
Terminals	Resistance	Terminals	Resistance
S to 95	1.00 ohms	S to #1	2.15 ohms
S to 105	1.02 ohms	S to #2	2.20 ohms
S to 115	1.10 ohms	S to #3	2.27 ohms
S to 125	1.11 ohms	S to #4	2.36 ohms
S to 190	1.70 ohms		
S to 210	1.86 ohms		
S to 230	2.10 ohms		
S to 250	2.26 ohms		

b. Rectifier (ref. no. 3). — Disconnect the jumper between end terminals. Using a battery-operated ohmmeter, the indicated resistance per section will be 1,500 to 2,000 ohms with the test prods connected one way and 25,000 to 40,000 ohms with the test prod connections reversed.

c. Capacitor (ref. nos. 4-1 and 4-2). — Resistance should be from 5,000 to 10,000 ohms when the positive terminal of the ohmmeter is connected to the positive terminal of the capacitor.

d. Choke (ref. no. 3). — Resistance should be from 2.0 to 2.5 ohms.

e. Resistor (ref. no. 18). — Resistance should be from 1,800 to 2,200 ohms.

19. Replacing parts.—Take particular care in soldering leads to the rectifier stack terminals. A drop of solder falling between the radiating disks may short out a part of the rectifier, causing it to overheat and fail. All parts are easily replaceable with a soldering iron and other small tools.

SECTION V — SUPPLEMENTARY DATA

	Paragraph
Table of replaceable parts	20
List of manufacturers	21

20. Table of replaceable parts.—See figures 3, 6, and 7 for location of parts.

Ref. No.	Stock No.	Name of part	Description	Function	Mfgr.	Signal Corps Drawing No.
1	2Z9605.3	Transformer	Genl. Transf. Corp. No. 8M54	Permits operation from 95-125 and 190-250 volts	5	SC-D-9547
2	3C347	Choke coil	Genl. Transf. Corp. No. 1N64	Filters d-c output	5	SC-D-9548
3	3H4860	Rectifier	Dry disk selenium rectifier #1DOB9FF1C	Rectifies a-c current	4	SC-D-9543-16
4-1 4-2	3DB500 5	Capacitor	500-μf, electrolytic 200-v, d-c (I. C. #20B70) or, 500-μf, electrolytic 200-v. d-c (Aerovox Type 2E)	Provides filtering for d-c output	7-11 13	SC-D-9543-17
5	3Z3256	Fuse mounting	Panel with fuse clips and screws #1056	Supports fuse in d-c circuit	9	SC-D-9552-5
6	3Z2605.2	Fuse	5-amp., type 3AG #MTH5, 250-v or, 5-amp., type 3AG #358, 5 amp., 250 v	To protect d-c circuit.	1 9	SC-D-9552-6
7	3Z9849.18	Switch	Double pole, single throw, #7320 or, Double pole, single throw, #81009K	Power switch	2 14	SC-A-1042
8	3E4060	Cord assembly	7 ft., 2 conductor with plug	Power supply cord	3	SC-D-5063
9	3Z12073	Terminal	Screw terminal #50-TAS	Tap panel terminals	8	SC-D-9552-3
10	3Z12046 2	Terminal	Wire terminal #X-991	Tap lead lug	10	SC-D-9552-4
11	6Z7789	Receptacle	Hubbell #7331	A-C output receptacle	6	SC-D-9543-19
12	6Z7815	Receptacle	Hubbell #9213 Twist-Tite	D-C output receptacle	6	SC-D-9543-20

13	3Z12046–1	Terminal	Wire terminal #2063	Connector to receptacle	10	SC-D-9543-27
14	3Z12046–1	Terminal	Wire terminal #2063	Connector to transformer mounting bolt	10	SC-D-9543-26
15	3H4699–87/P1	Terminal panel	Terminals on bakelite panel	For transformer tap terminals and fuse mounting	8	SC-D-9543-25
16	3Z1024	Fuse clip	½″ fuse clip or, ½″ fuse clip, 30-amp., SK2371	For fuse in a-c circuit	1 15	SC-D-9543-21
17	3Z2615.10	Fuse	15 amp., #25015 or, 15-amp., Eco #1115	Protects a-c circuit	1 16	SC-D-9543-22
18	3Z6200–43	Resistor	2,000 ohm, X-1103 or, 2,000 ohm, Type DG with Type 2 terminals	Bleeder resistor for d-c circuit	12 17	SC-D-9543-18

21. List of manufacturers.

No.	*Name*	*Address*
1.	Bussmann Manufacturing Co.	University and Jefferson Sts., St. Louis, Mo.
2.	Cutler-Hammer, Inc.	1401 W. St. Paul Avenue, Milwaukee, Wis.
3.	Essex Wire Corporation	14310 Woodward Avenue, Detroit, Mich.
4.	Benwood-Linze Company	1815 Locust Street, St. Louis, Mo.
5.	General Transformer Corp.	1250 W. Van Buren Street, Chicago, Ill.
6.	Harvey-Hubbell, Inc.	Bridgeport, Conn.
7.	Industrial Condenser Corp.	1725 W. North Avenue, Chicago, Ill.
8.	Howard B. Jones	2300 Wabansia Avenue, Chicago, Ill.
9.	Littlefuse, Inc.	4757 Ravenswood Avenue, Chicago, Ill.
10.	Patton-MacGuyer Company	Baker St. and Virginia Ave., Providence, R. I.
11.	Solar Manufacturing Co.	586 Avenue A, Bayonne, N. J.
12.	Utah Radio Products Co.	820 Orleans Street, Chicago, Ill.
13.	Aerovox Corporation	New Bedford, Mass.
14.	Arrow Hart & Hegeman Elec. Co	106 Hawthorn Avenue, Hartford, Conn.
15.	Square "D" Company	Milwaukee, Wis.
16.	Economy Fuse & Mfg. Co.	Greenview Ave. at Diversey Parkway, Chicago, Ill.
17.	International Resistance Co.	401 N. Broad Street, Philadelphia, Pa.

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